

WE CLAIM:

- Sub. 9c
- 5 1. A fine fiber filter media comprising a sheet-like filter substrate, the sheet having a first surface and a second surface, the first surface and the second surface each comprising a layer of fine fiber having a diameter of about 0.001 to 0.5 microns, the layer having a thickness of less than 5 microns, the fine fiber formed in an amount effective to obtain an overall efficiency (under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity) of less than 90% in any one layer and to obtain an efficiency of greater than 90% in both layers combined.
- 10 2. The filter media of claim 1 wherein the efficiency of the fine fiber layer on the first surface is different than the efficiency of the fine fiber layer on the second surface.
- 15 3. The filter media of claim 1 wherein the efficiency of the fine fiber layer on a downstream surface is greater than the efficiency of the fine fiber layer on an upstream surface.
- 20 4. The filter media of claim 1 wherein the sheet-like filter substrate has a thickness of about 0.1 to 3 millimeters, the first surface and the second surface each comprising a layer of fine fiber having a diameter of about 0.01 to 0.3 microns the layer having a thickness of less than 3 microns, the fine fiber selected such that after test exposure for a test period of 16 hours to test conditions of 140°F air and a relative humidity of 100% retains greater than 50% of the fiber unchanged for filtration
- 25 purposes.
- 30 5. The filter media of claim 1 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of less than 85% and in both layers combined to obtain an overall efficiency of greater than 90% and the substrate has an efficiency of about 5 % to about 80%.

6. The filter media of claim 1 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of less than 80% and in both layers combined to obtain an overall efficiency of greater than 85% and the substrate has an efficiency of about 20% to about 80%.

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7. The filter media of claim 1 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 85% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 5% to about 80%.

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8. The filter media of claim 1 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 80% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 20% to about 80%.

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9. The filter media of claim 4 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an overall efficiency of less than 75% and in both layers combined to obtain an efficiency of greater than 80%, and retains greater than 30% of the fiber unchanged for filtration purposes.

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10. The filter media of claim 1 wherein the fine fiber forming an interlocking mesh of fiber having on the average a pore size between fibers in the web of less than about 3 microns; wherein the substrate has an efficiency greater than the efficiency of a single sided media and has a lifetime, defined as an increase in pressure drop over the filter of about 3 inches H₂O at test conditions of 10 ft/min.

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11. A method of removing a particulate from an air borne stream, the particulate comprising a liquid particulate, a solid particulate or mixtures thereof, the method comprises:

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(a) placing a filter structure in an air stream; and

5 (b) directing the air stream through the filter structure while monitoring the useful life of the filter structure; said filter structure comprising a fine fiber filter media and sheet-like filter substrate, the sheet having a first surface and a second surface, the first surface and the second surface each comprising a layer of fine fiber having a diameter of about 0.001 to 0.5 microns the layer having a thickness of less than 5 microns, the fine fiber layer formed in an amount effective to obtain an efficiency under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity of less than 90% in any one layer and to obtain an efficiency of greater than 90% in both layers combined.

15 12. The method of claim 11 wherein the efficiency of the fine fiber layer on the first surface is different than the efficiency of the fine fiber layer on the second surface.

13. The method of claim 11 wherein the efficiency of the fine fiber layer on a downstream surface is greater than the efficiency of the fine fiber layer on an upstream surface.

20 14. The method of claim 11 wherein the sheet-like filter substrate has a thickness of about 0.01 to 0.5 millimeters, the first surface and the second surface each comprising a separate layer of fine fiber having a diameter of about 0.01 to 0.3 microns the layer having a thickness of less than 3 microns, the fine fiber selected such that after test exposure for a test period of 16 hours to test conditions of 140°F air and a relative humidity of 100% retains greater than 50% of the fiber unchanged for filtration purposes.

30 15. The method of claim 11 wherein the fine fiber layer formed in an amount effective to obtain an efficiency of less than 85% in any one layer and to obtain an efficiency of greater than 90% in both layers combined.

16. The method of claim 11 wherein the fine fiber layer formed in an amount effective to obtain an efficiency of less than 80% in any one layer and to obtain an efficiency of greater than 85% in both layers combined.

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Sub. A8 17. The method of claim 11 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 85% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 20% to about 80%.

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18. The method of claim 11 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 80% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 20% to about 80%.

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19. The method of claim 11 wherein the fine fiber layer formed in an amount effective to obtain an efficiency of less than 75% in any one layer and to obtain an efficiency of greater than 80% in both layers combined.

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20. The method of claim 11 wherein the fine fiber forming an interlocking mesh of fiber having on the average a pore size between fibers in the web of less than about 3 microns; wherein the filter media has an efficiency greater than the efficiency of a single sided media and has a lifetime, defined as an increase in pressure drop over the filter of about 3 inches H₂O at test conditions of 10 ft/min.

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21. The method of claim 11 wherein the particulate comprises a solid particulate, a liquid particulate or mixtures thereof.

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22. The method of claim 21 wherein the particulate comprises residual components of combustion.

23. The method of claim 21 wherein the particulate comprises a fatty oil, a fatty acid or mixtures thereof.

24. The method of claim 21 wherein the particulate comprises soot, a grit or mixtures thereof.

25. A filter structure comprising one or more sheet like filter substrate and three or more layers of fine fiber, each sheet like substrate having a first surface and a second surface, the surfaces comprising three or more layers of the fine fiber on the substrate, each layer comprising fine fiber having a diameter of about 0.01 to 0.5 micron, each layer having a thickness of less than 5 microns, the fine fiber formed in the amount effective to obtain an efficiency under ASTM-1215-89 with monodisperse 0.78 micron polystyrene latex particles at 20 ft/min velocity of less than 90% in any one layer and to obtain an overall efficiency of greater than 90% in the layers combined.

26. The filter media of claim 25 wherein the efficiency of the fine fiber layer on the first surface is different than the efficiency of the fine fiber layer on the second surface.

27. The filter media of claim 25 wherein the efficiency of a fine fiber layer on a downstream surface is greater than the efficiency of a fine fiber layer on an upstream surface.

28. The filter media of claim 25 wherein the sheet-like filter substrate has a thickness of about 0.01 to 3 millimeters, any surface comprising a layer of fine fiber having a diameter of about 0.01 to 0.5 microns the layer having a thickness of less than 3 microns, the fine fiber selected such that after test exposure for a test period of 16 hours to test conditions of 140°F air and a relative humidity of 100% retains greater than 50% of the fiber unchanged for filtration purposes.

29. The filter media of claim 25 wherein the sheet-like filter substrate has a thickness of about 0.3 to 1 millimeters.

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30. The filter media of claim 25 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of less than 85% and in both layers combined to obtain an overall efficiency of greater than 90%.

10 31. The filter media of claim 25 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of less than 80% and in both layers combined to obtain an overall efficiency of greater than 85%.

15 32. The filter media of claim 25 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 85% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 5% to about 80%.

20 33. The filter media of claim 25 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an efficiency of about 40% to 80% and in both layers combined to obtain an overall efficiency of greater than 65% and the substrate has an efficiency of about 20% to about 80%.

25 34. The filter media of claim 25 wherein the fine fiber layer formed in an amount effective, in each layer, to obtain an overall efficiency of less than 75% and in both layers combined to obtain an efficiency of greater than 80%, and retains greater than 30% of the fiber unchanged for filtration purposes.

30 35. The filter media of claim 25 wherein the fine fiber forming an interlocking mesh of fiber having on the average a pore size between fibers in the web of less than about 3 microns; wherein the substrate has an efficiency greater than the efficiency of a single sided media and has a lifetime, defined as an increase in pressure drop over the filter of about 3 inches H₂O at test conditions of 10 ft/min.